ICEBO 2008

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Ultra-Thin, Energy-Efficient Façades - a Contradiction in Terms?
-
Challenges and Novel Strategies

Hans-Peter Ebert

Bavarian Center for Applied Energy Research (ZAE Bayern)

Division: Functional Materials for Energy Technology

Würzburg, Germany

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Energy Use in Europe

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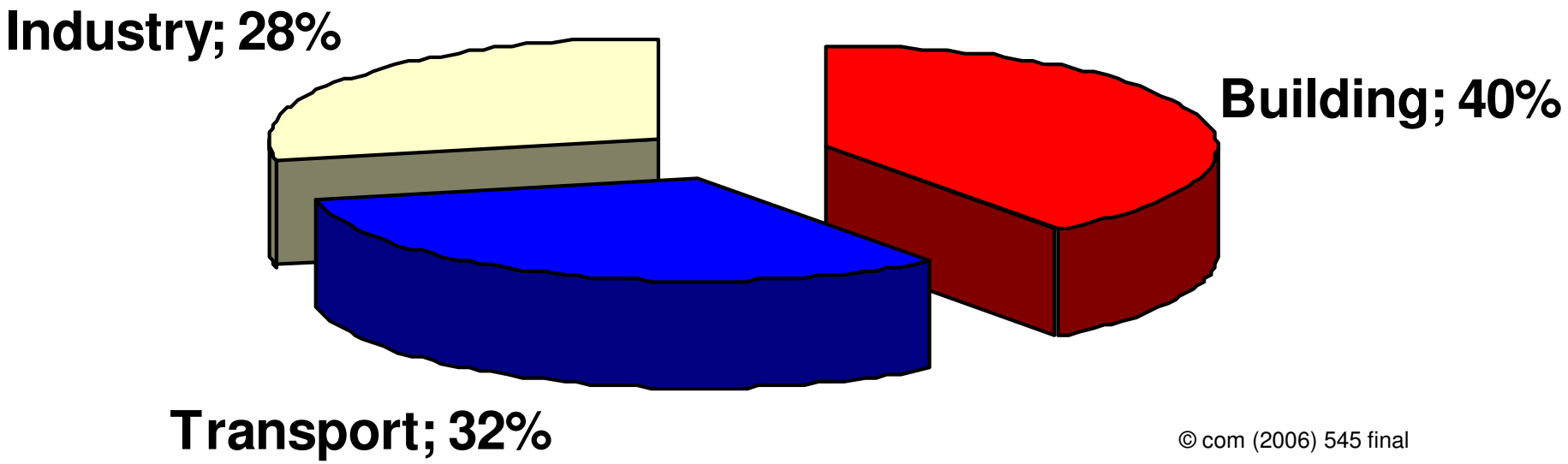

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Thermally optimized façades reduces energy consumption for heating and for cooling

History of Ultra-Thin, Energy-Efficient Façades

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Wall thickness: 60 to 70 mm
U-value ≈ 1.3 W/(m²K)
Average temperature -3.2 °C

Advantages of Ultra-Thin Façades

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- saving of space (centre of cities)
- low weight
- more design freedom

Critical Aspects of Ultra-Thin Façades

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- low heat capacity

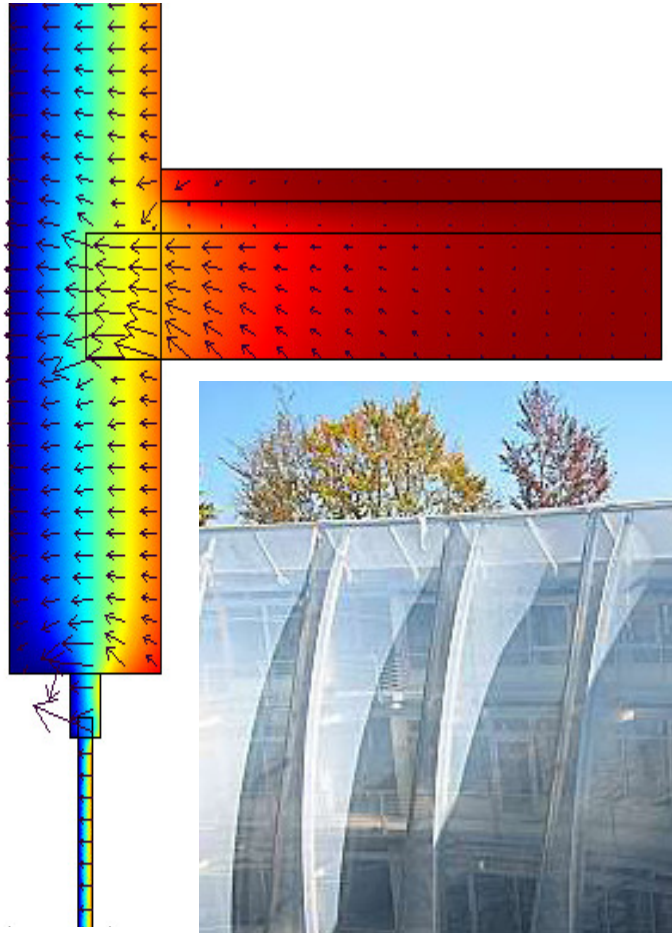
need for control, PCM

- high U-Value

improved thermal insulations

- thermal bridges

more planning work



Further Content

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- Motivation
- Vacuum Insulation Panels (VIP)
- Vacuum Glazing
- Textile Architecture
- Conclusion - Outlook

Comparison of Thermal Insulation Materials

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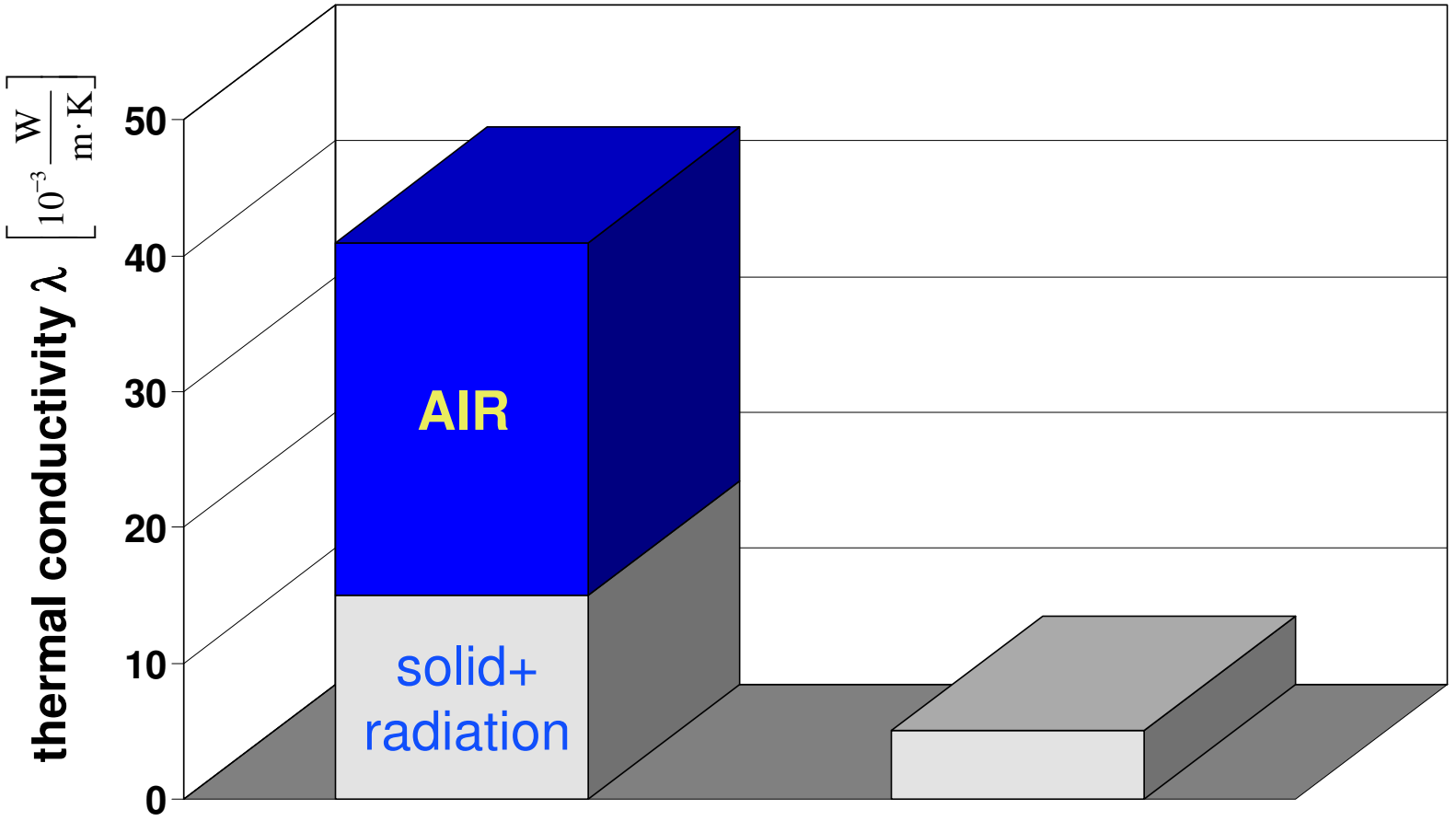
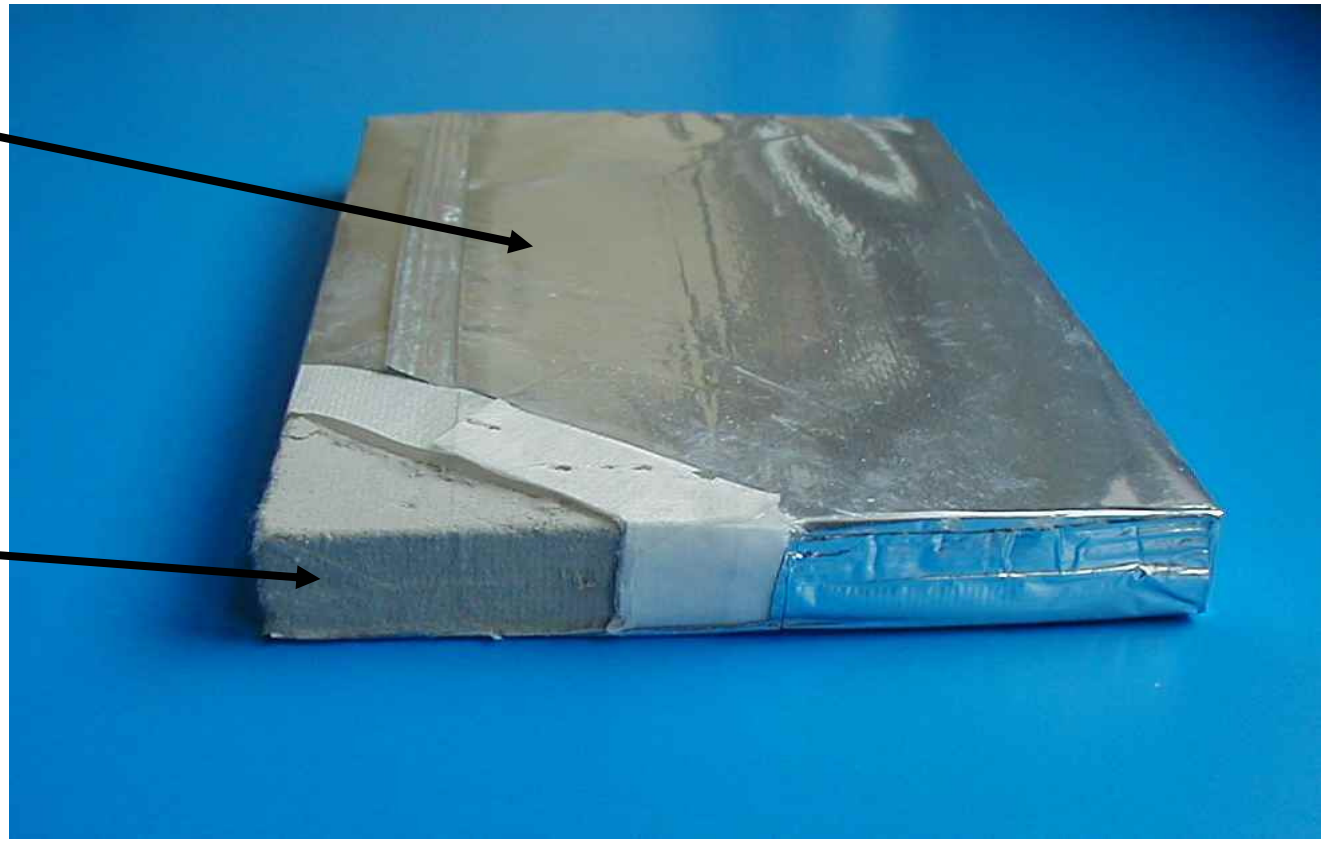


Components of a VIP

nanostructured high-barrier laminate

nanoporous load-bearing filler material



Retrofitting a Terrace House with VIPs

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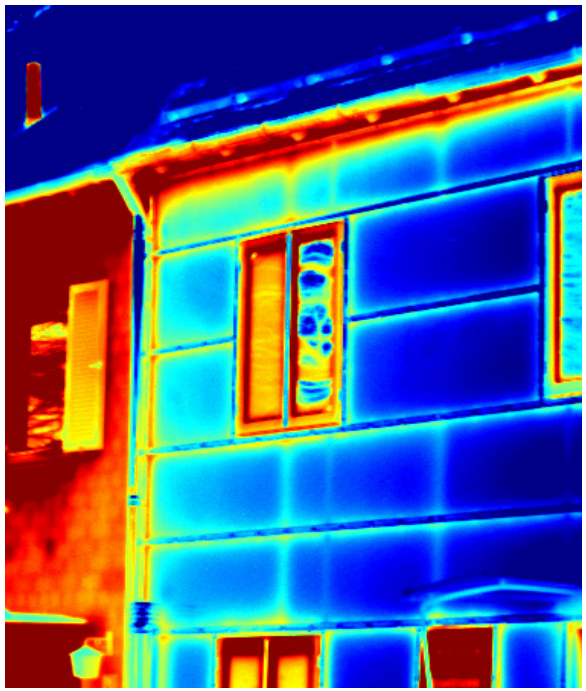

$U\text{-value}_{before} = 1.0\ W/(m^2K)$

$U\text{-value}_{after} = 0.15\ W/(m^2K)$

Thermal imaging:
Blue areas indicate excellent thermal insulation performance

Vacuum insulation glass (VIG)

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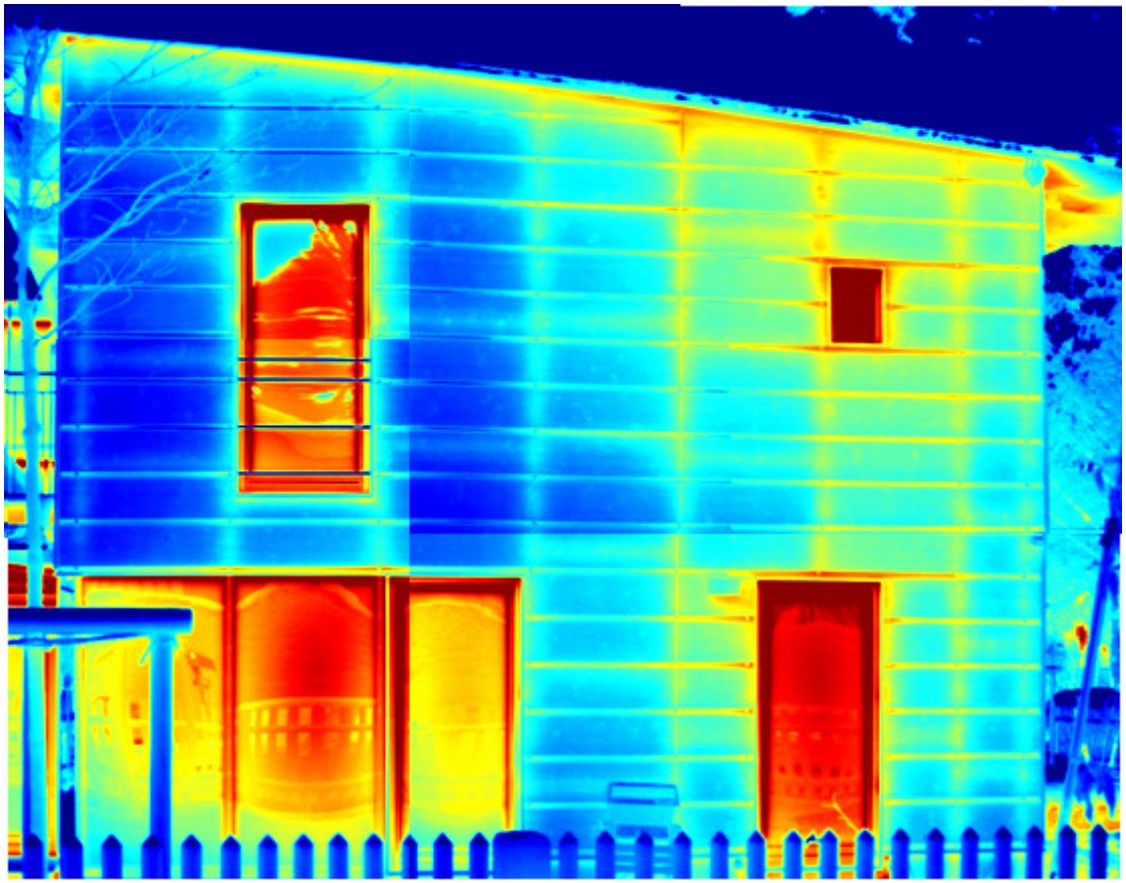
Windows represent thermal weak spots of buildings



- **façade:**
  $U \leq 0.3$ W/(m²K)
- **double glazing:**
  $U \approx 1.1$ W/(m²K)
- **triple glazing:**
  $U \approx 0.6$ W/(m²K)

Analyses of Heat Transfer

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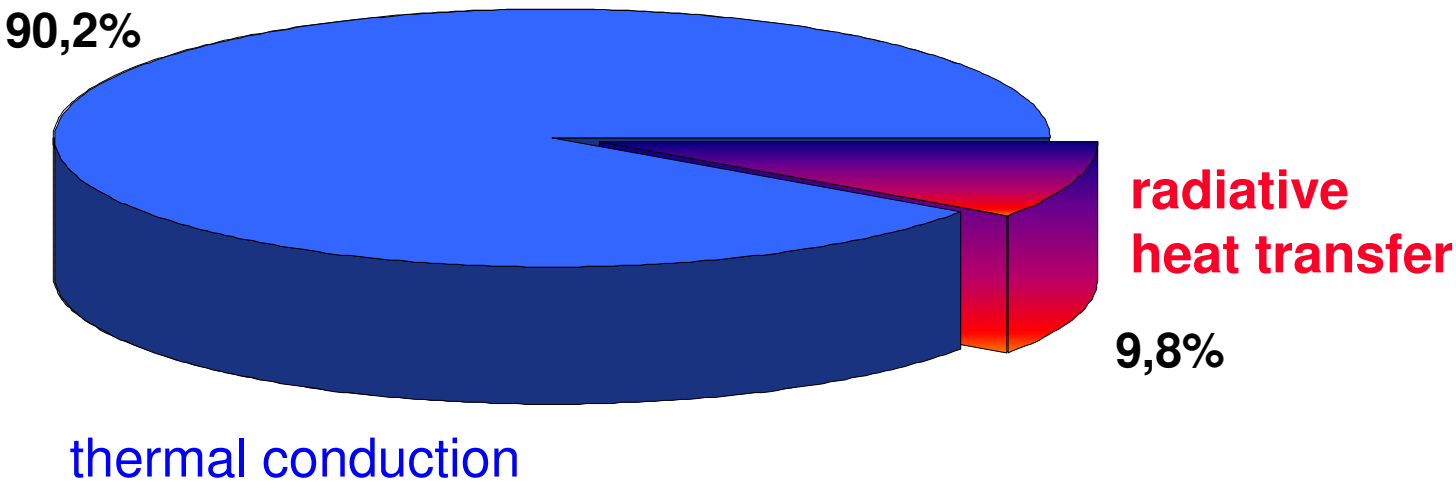
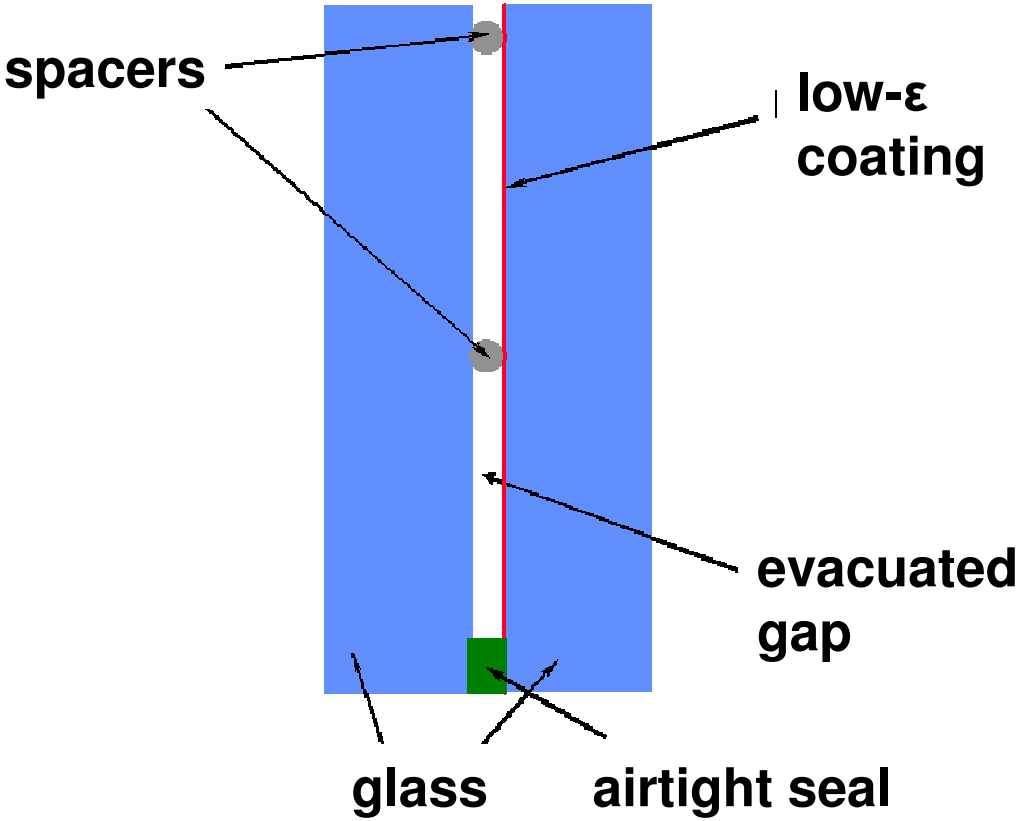
Thermal insulation glazing:

U_g = 1.3 W/(m²K)
ε= 0.03
gap: 16 mm air

Components of the U-value



VIG-Design



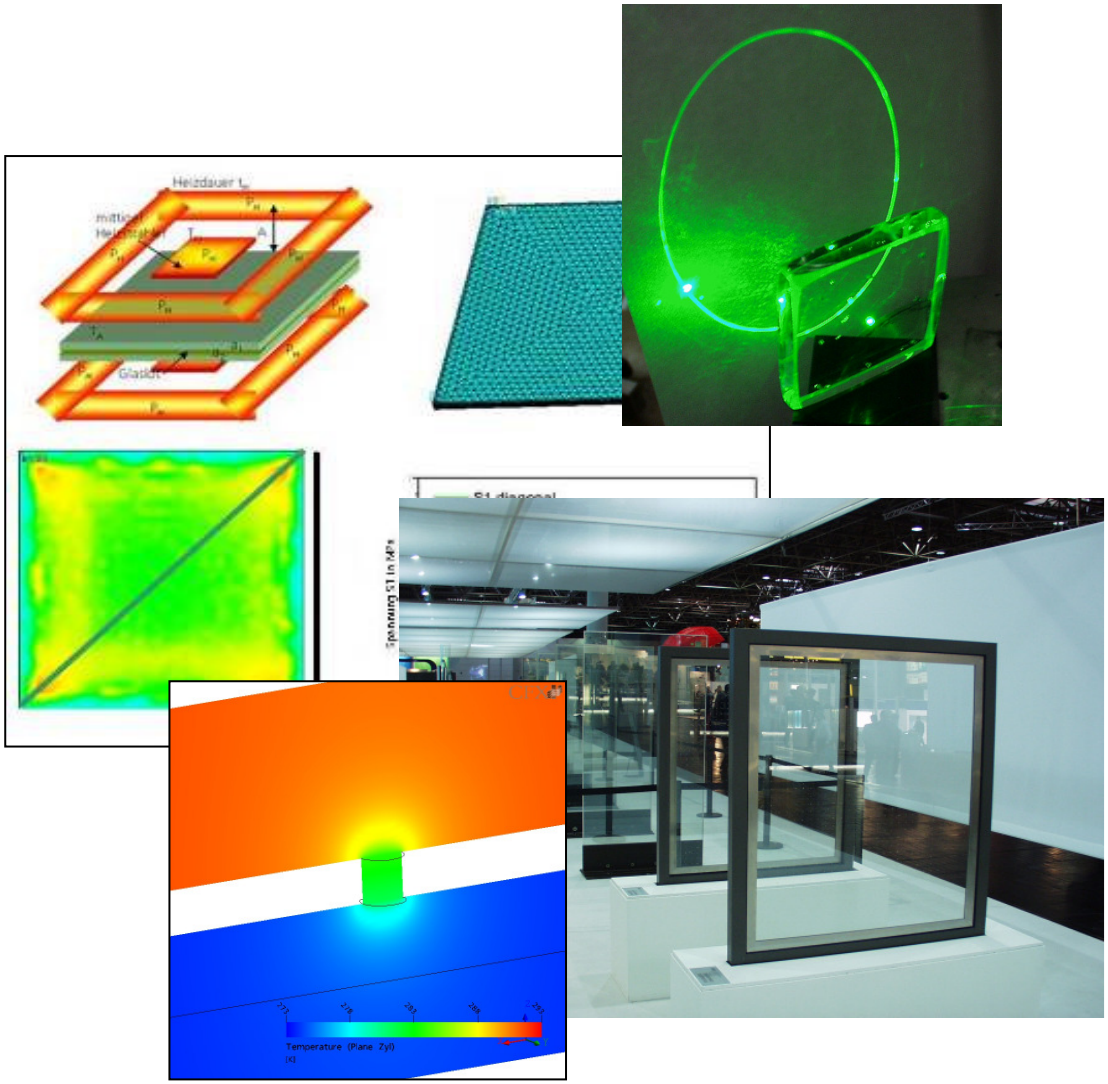
Thinner and
lighter than triple glazing:

- system thickness ≤ 9 mm
- 2 x 4 mm float glass

U < 0.5 W/(m²K)

Challanges

- Thermal optimization
- Innovative edge construction
- Optical optimization (spacers!)
- Gas tightness
- Mechanical stability



VIG Prototypes

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prototypes at glasstec 2007

U-value = 0.5 W/(m²K)

commercial production planned for 2009

Thermally Improved Window Frames
TopTherm 90

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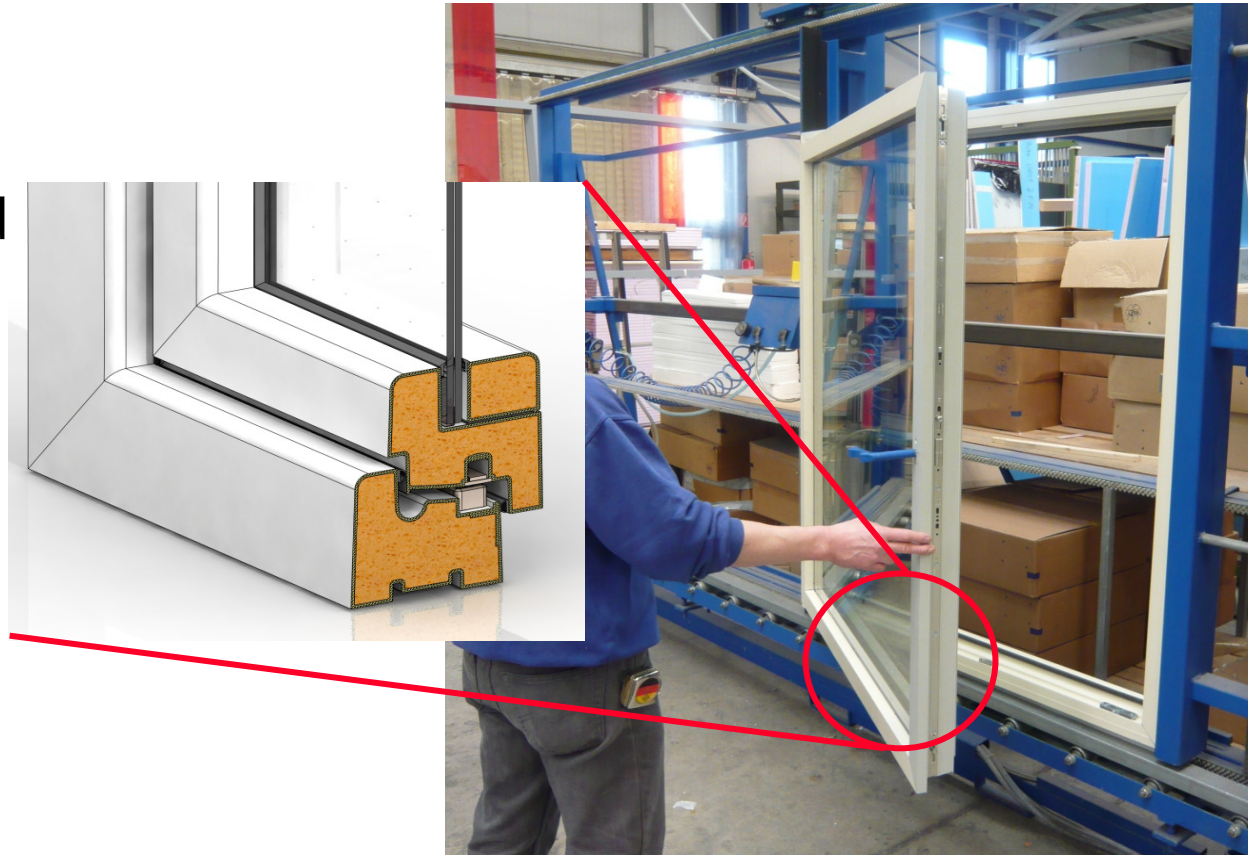
- PU-foam kernel for thermal insulation
- thin polymeric layer for improved mechanics and surface texture
- U_f = 0,7 W/(m2K) @ 90 mm system thickness
- low weight
- simple production and installation



Thermal Performance of Windows

Northern Side, test reference year Würzburg, Germany

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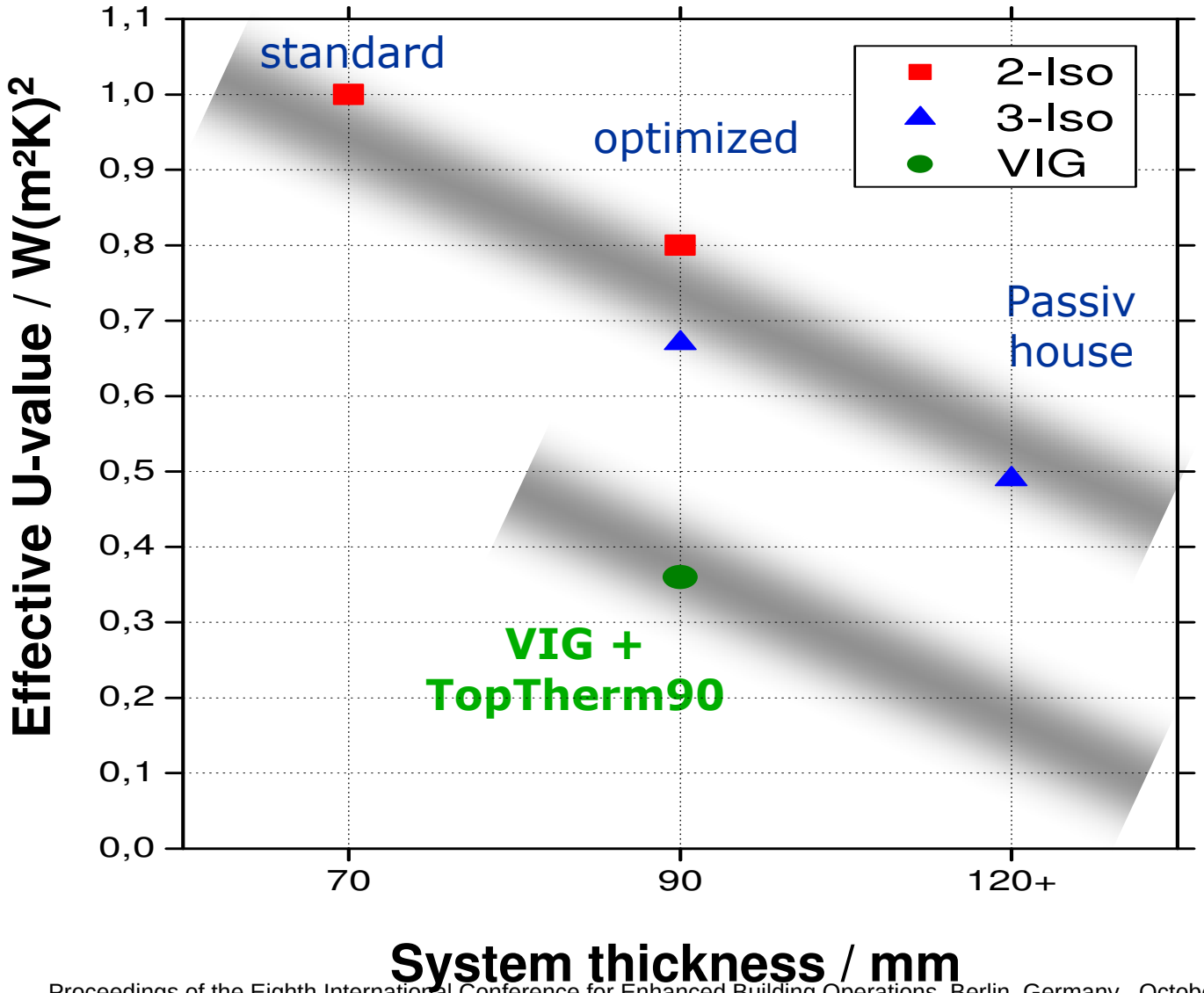

Textile Architecture

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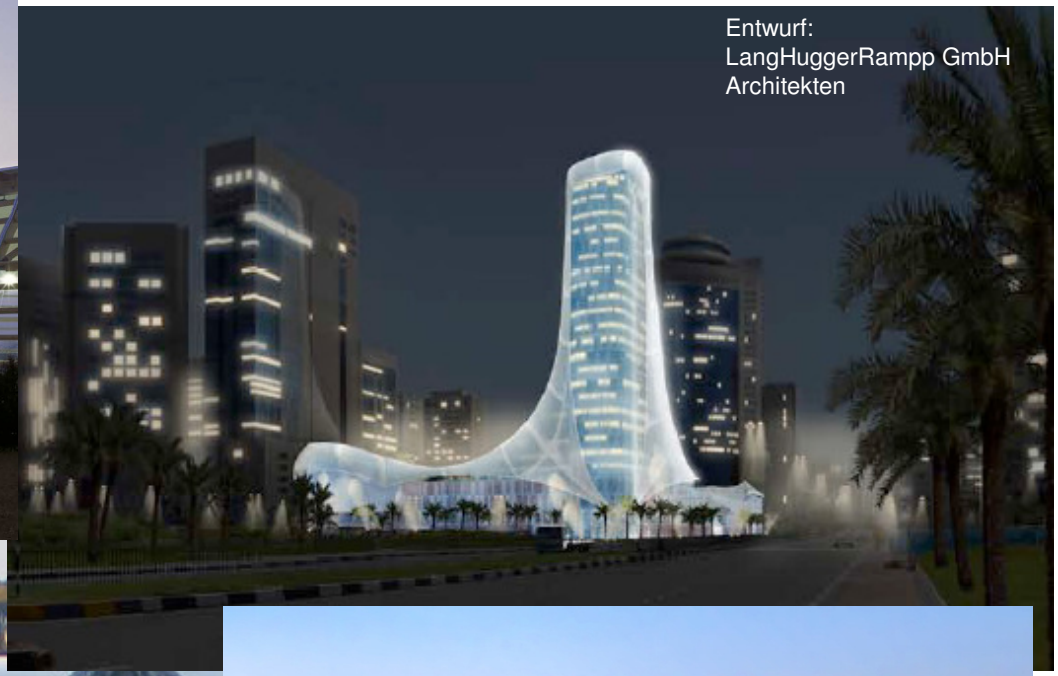

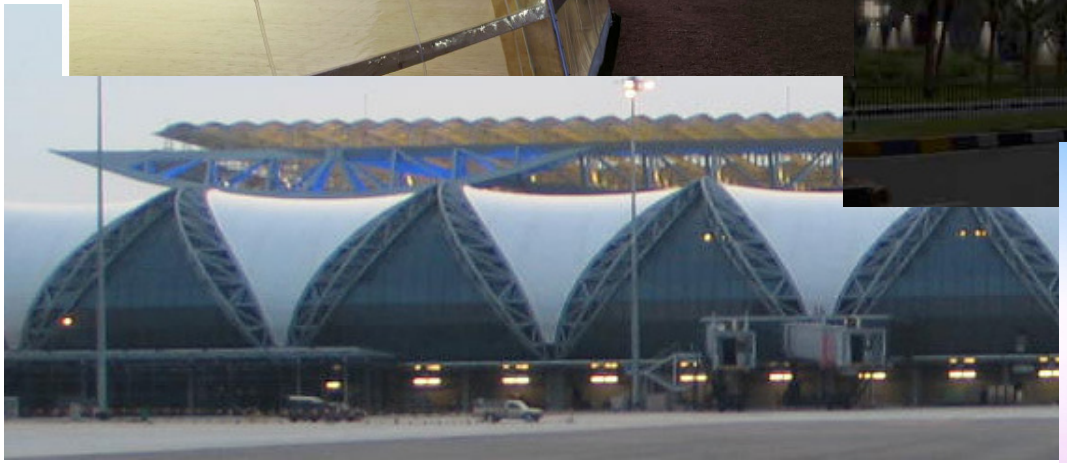

Textile Architecture
Multifunctional Membranes

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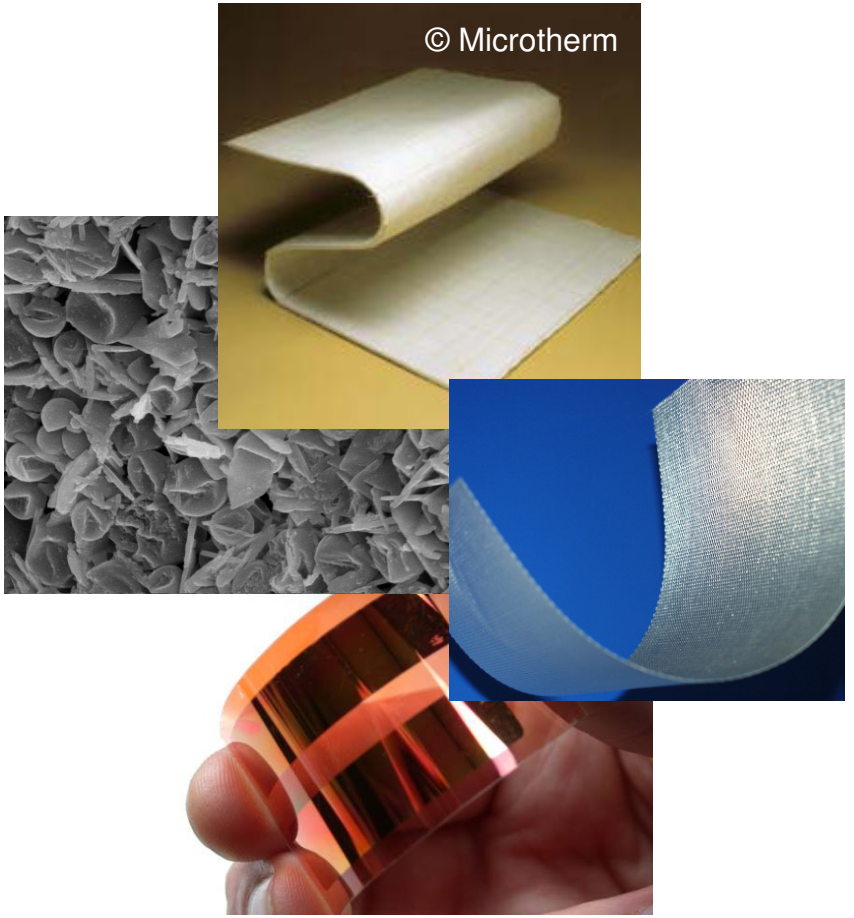
- thermal insulation
- heat storage (PCM)
- low-ε coatings
- photovoltaic
- …



Textile Architecture

Properties of low-ε coatings

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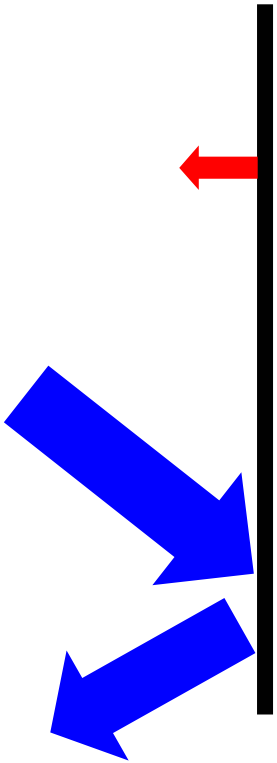
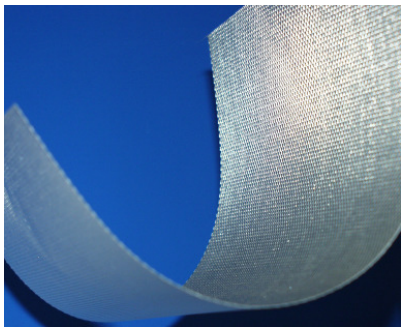


low emission of thermal radiation

high reflection of thermal radaition

NBIA

glass fiber fabrics with aluminum coating



low thermal emittance $\varepsilon \Rightarrow$ low emission of thermal radiation $\Rightarrow$ saving of energy

Textile Architecture
Transparent low-ε coatings

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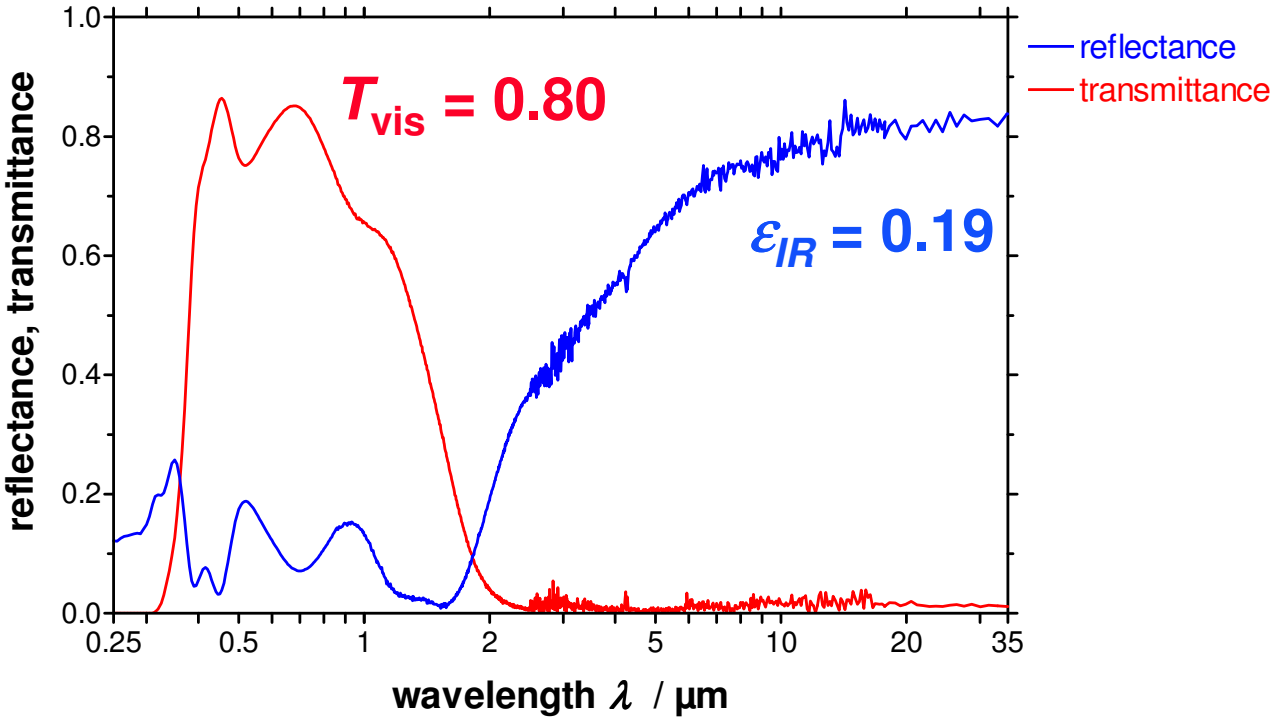
- TCO (transparent conductive oxide) layers on textiles
- TCO: e.g. ITO: Indium Tin Oxide, AZO: Aluminum Zinc Oxide
- coating by a sol-gel process



Conclusion

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- Ultra-thin façades could be energy efficient!
- Innovative materials and systems offer the potential for more energy-efficient systems (VIP, VIG, PCM, low-ε coating)
- Textile architecture is an challenging field with a great potential for the realization of energy efficient façades.

Thank you for listening!

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Further information:

www.vip-bau.de
www.vig-info.de
www.hwff.info
www.pcm-demo.de
www.zae-bayern.de

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